CERTIFICATION OF TRANSLATION

I, ***Hye-young Jang***, an employee of Y.P.LEE, MOCK & PARTNERS of Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of perjury that I understand the Korean language and the English language; that I am fully capable of translating from Korean to English and vice versa; and that, to the best of my knowledge and belief, the statement in the English language in the attached translation of ***Korean Patent Application No. 10-2003-0049132*** consisting of 11 pages, have the same meanings as the statements in the Korean language in the original document, a copy of which I have examined.

Signed this 10th day of July 2006

Hye-young Jang

ABSTRACT

[Abstract of the Disclosure]

Provided is a high-density optical disk. The optical disk includes a substrate with pits and one or more mask layers with a super resolution near field structure, which are made of a mixture of a dielectric material and metal particles. The optical disk can be obtained without decreasing the wavelength of a laser diode or increasing the numerical aperture of an objective lens.

[Representative Drawing]

FIG. 2

[Keywords]

Super resolution near field structure

SPECIFICATION

[Title of the Invention]

High-Density Optical Disk

[Brief Description of the Drawings]

FIG. 1 is a schematic view of an optical disk with a conventional structure.

FIG. 2 is a schematic view of an optical disk with the structure as defined in Example 1 of the present invention.

FIG. 3 is a graph showing the results of performance evaluation for the optical disks prepared in Examples 1-3 and Comparative Example 1.

<Description of reference numerals for main components of Drawings>

10: substrate	11: mask layer
12: recording layer	13: reflective layer
14: dielectric layer	15: mark
16: metal particle	17: pit

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to an optical disk, and more particularly, to a high-density readable only optical disk with a super resolution near field structure, which can read marks with a size smaller than the resolution of a laser beam.

Because optical disks have very small recording area per recording unit in comparison with existing magnetic recording media, they have been widely used as high-density recording media. According to their characteristics, optical disks are classified into a Read Only Memory (ROM) type, a Write Once Read Many (WORM) type, and an erasable type. The ROM type of optical disks can only read pre-recorded data, the WORM type of optical disks allows a user to write data onto a disk only once, and the erasable type of optical disks allows a user to erase and re-record data.

One example of the WORM optical disks is a Compact Disk Recordable (CD-R) disk. In a CD-R disk, when a recording laser beam with a wavelength of 780 nm is

focused on a recording layer made from an organic dye material such as cyanine and phthalocyanine, bonds in the organic dye material are broken. At the same time, the structures of a substrate and a reflecting layer are optically changed. Under this process, data are recorded on a CD-R disk. The recorded data are read with a low power of 1 mW or less. A CD-R disk has a storage capacity of about 650 MB and thus is widely used for recording and reading various types of data such as audio and video.

However, the storage capacity of optical recording media such as CD-R or CD-Rewritable (CD-RW) which require a recording wavelength of 780 nm is insufficient to record dynamic image data. Therefore, such optical recording media with a small storage capacity are impractical in today's complex multimedia environment.

In order to solve this problem, Digital Versatile Disks (DVDs) which require a shorter laser wavelength of 630-680 nm have been developed. DVDs have a storage capacity of 2.7 to 4.7 GB (on one side). Generally, DVDs can be classified into a DVD-read only memory (DVD-ROM) type, a DVD-recordable (DVD-R) type, a DVD-random access memory (DVD-RAM) type, and a DVD-rewritable (DVD-RW) type. Recording on the DVD-R disks is accomplished through the use of a recording layer in which bonds in an organic dye material are broken upon exposure to a recording laser beam. As for the DVD-RAM and the DVD-RW disks, a recording layer's phase change alters the optical characteristics of disks, and thus, data are recorded on or erased from disks. In particular, the DVD-R disks using an organic dye material are compatible with DVD-ROM, cost effective, and have a large storage capacity in comparison with other recording media. For these reasons, much attention has been paid to the DVD-R disks at present.

As can be seen from the above description, the most important issue in many optical media is now to increase the storage capacity. In this regard, various attempts have been made to increase the storage capacity. The storage capacity of optical disks mainly depends on the number of tiny pits on a predetermined surface of optical disks and the characteristics of a laser beam used to correctly read the pits. Generally, light output from a laser diode spreads in the form of a beam with a definite width due to

diffraction in spite of using an optical pickup's objective lens. This beam size is called "diffraction limit". General optical disks have a reading resolution limit, given by the expression: $\lambda/4NA$, where λ is the wavelength of a light source and NA is the numerical aperture of an objective lens. As can be seen from the above expression, the storage capacity of optical disks can be increased by shortening a light source's wavelength or using an objective lens with a larger NA. However, there are limitations in that recent laser technologies cannot provide such a shorter wavelength laser and an objective lens with lager NA is expensive. Furthermore, as the NA of an objective lens increases, a distance (working distance) between a pickup and a disk is remarkably shortened, and thus, the pickup and the disk might collide with each other. As a result, damages to the surface of the disk may be caused, resulting in data loss.

In order to overcome the reading resolution limit, optical disks having a super resolution near field structure (super-RENS) have been studied. In optical disks having such a super-RENS, a mask layer made of silver oxide is mainly used. FIG. 1 schematically shows an optical disk with a silver oxide mask layer. In optical disks with the structure of FIG. 1, silver oxide is dissociated into silver particles and oxygen for data recording. On the other hand, for data reading, plasmons are formed on the surfaces of the silver particles. Such surface plasmons induce near field reading (NFR). Therefore, very small marks beyond the diffraction limit can be read.

A mask layer made of metal oxide such as silver oxide can be used in WORM optical recording media in which silver oxide is dissociated into silver particles and oxygen for data recording. This means that metal particles inducing a super resolution effect are generated during a recording process. For this reason, there is a problem in that a silver oxide mask layer cannot be used in ROM optical disks that store data in the form of pits on their substrates instead of a recording process.

[Technical Goal of the Invention]

The present invention provides a high-density readable only optical disk with large storage capacity. The optical disk can be obtained without decreasing the wavelength of a laser diode or increasing the numerical aperture of an objective lens.

[Structure and Operation of the Invention]

According to an aspect of the present invention, there is provided a high-density readable only optical disk comprising: a substrate with pits and one or more mask layers with a super resolution near field structure, which are made of a mixture of a dielectric material and metal particles.

The dielectric material may be metal oxide, nitride, sulfide, fluoride, or a mixture thereof.

Preferably, the dielectric material is $ZnS\text{-}SiO_2$.

The metal particles may be derived from gold, platinum, rhodium, palladium, or a mixture thereof.

Preferably, the metal particles are platinum particles.

The optical disk may further include one or more reflective layers.

The optical disk may further include a dielectric layer on at lease one of the upper and lower surfaces of the mask layer.

Hereinafter, the present invention will be described in more detail with reference to the accompanying drawings.

FIG. 2 shows an optical disk according to an embodiment of the present invention. An optical disk of FIG. 2 comprises a transparent substrate 10 with pits 17 and a mask layer 11 formed on the substrate 10.

The substrate 10 is very transparent to a wavelength of a recording laser. The substrate 10 is formed by a conventional substrate fabrication method such as injection molding using a material with excellent impact resistance, heat resistance, and weatherability. Examples of the substrate material include polycarbonate, polymethylmethacrylate, epoxy, polyester, and amorphous polyolefin.

The mask layer 11 of the present invention is formed using fine metal particles dispersed in a dielectric material instead of using a conventional silver oxide. The size of the fine metal particles is smaller than that of a laser beam. According to the

present invention, since the fine metal particles are used as a source of a surface plasmon, they are suitable for readable only disks.

The dielectric material to be used in the mask layer 11 is metal oxide, nitride, sulfide, fluoride, or a mixture thereof. For example, SiO_2, Al_2O_3, Si_3N_4, SiN, ZnS, or MgF_2 can be used. Preferably, the metal particles to be dispersed in the mask layer 11 are derived from a noble metal such as gold, platinum, rhodium, and palladium. In this case, because the dielectric material and the metal particles are not chemically reacted with each other, the original shape of the fine metal particles can be maintained. However, use of silver particles is not preferable. This is because the silver particles react with sulfur of the dielectric material, thereby deteriorating the characteristics of the mask layer 11.

Meanwhile, the mask layer 11 may be deposited by a sputtering process. The target of the sputtering process is a mixture of the dielectric material and the fine metal particles. Therefore, the fine metal particles with a size smaller than a laser beam can be dispersed in the dielectric material using the sputtering process.

Although not shown in FIG. 2, an optical disk of the present invention may further include a reflective layer. The reflective layer is used to secure high reflectivity when data are recorded or read. In this regard, it is preferable to use a metal with high heat conductivity and reflectivity as the material for the reflective layer. The reflective layer may be made of one selected from the group consisting of Au, Al, Cu, Cr, Ag, Ti, Pd, Ni, Zn, Mg, and an alloy thereof. The reflective layer is formed to a thickness of 50 to 150 nm by means of a conventional method such as vacuum deposition, e-beam, and sputtering. It is preferable to limit the thickness of the reflective layer to a range of 60 to 120 nm to secure a sufficient reflectivity and reliability.

An optical disk of the present invention may further include a dielectric layer, between the mask layer and the substrate, between the mask layer and the reflective layer, or on the upper and the lower surfaces of the mask layer. A dielectric layer between the mask layer and the substrate acts to prevent thermal damage to the

substrate. On the other hand, a dielectric layer between the mask layer and the reflective layer acts as a diffusion prevention layer.

An optical disk of the present invention may further include a protective layer. The protective layer acts to protect other layers. The protective layer can be formed using a conventional method such as spin coating. In detail, an epoxy- or acrylate-based ultraviolet light curable resin, a transparent material that exhibits a high impact strength and is curable using an ultraviolet light, is spin coated on the reflective layer, followed by ultraviolet light curing, to thereby form the protective layer.

Hereinafter, the present invention will be described in more detail by way of Examples, but is not limited thereto.

Example 1

A polycarbonate (PC) substrate with a thickness of 0.6 mm was prepared. The substrate had pits and a track pitch of 0.74 μm which is the same as that of digital versatile disk (DVD). A $ZnS-SiO_2$ target and Pt target were co-deposited on the substrate by sputtering at 400 W and 160 W, respectively, to form a mixed thin film. At this time, an Ar gas was supplied at a rate of 20 sccm, a deposition pressure was 1.5 mTorr, and the volume ratio of $ZnS-SiO_2$ to Pt in the thin film was 80 to 20.

Example 2

A polycarbonate (PC) substrate with a thickness of 0.6 mm was prepared. The substrate had pits and a track pitch of 0.74 μm. A $ZnS-SiO_2$ dielectric layer and a $ZnS-SiO_2$+Pt mask layer were deposited on the substrate by sputtering. Then, an Ag reflective layer was deposited to a thickness of 100 nm by sputtering. Then, a light curable resin based protective layer was spin coated on the reflective layer. In this case, the $ZnS-SiO_2$+Pt mask layer was formed in the form of a mixed thin film with a thickness of 50 nm by co-sputtering a $ZnS-SiO_2$ target and a Pt target at 400 W and 160 W, respectively. An Ar gas was supplied at a rate of 20 sccm, a deposition pressure was 1.5 mTorr, and the volume ratio of $ZnS-SiO_2$ to Pt in the thin film was 80 to 20.

Example 3

A readable only disk was prepared in the same manner as in Example 2 except that a $ZnS\text{-}SiO_2$ layer was further formed between the mask layer and the reflective layer.

Comparative Example 1

A polycarbonate (PC) substrate with a thickness of 0.6 mm was prepared. The substrate had pits and pre-grooves with a track pitch of 0.74 μm. An Ag reflective layer was deposited on the substrate by sputtering. Then, a light curable resin based protective layer was spin coated on the reflective layer. As a result, a readable only optical disk without a mask layer was formed.

Experimental Example 1

Performances of the disks of Examples 1-3 and Comparative Example 1 were evaluated using evaluation equipment for DVD with a beam wavelength of 635 nm and a pickup of a numerical aperture (NA) of 0.60. For this, a carrier to noise ratio (C/N) value was measured at a linear velocity of 6 m/s and a reading power of 4 mW and the result is shown in FIG. 3. As shown in FIG. 3, a reading resolution limit (λ/4NA) was 265 nm and the minimum pit length of DVD was 400 nm. In the optical disk of Comparative Example 1, no C/N values were obtained in 250 and 200 nm pits smaller than the reading resolution limit (265 nm). However, in the optical disks of Examples 1-3, a C/N value of more than about 40 dB which is of a practical level was obtained in a 250 nm pit. This experiment result demonstrates that a super resolution effect can be obtained in an optical disk of the present invention.

[Effect of the Invention]

As apparent from the above description, the present invention provides a high-density readable only optical disk with large storage capacity. The optical disk can be obtained without decreasing the wavelength of a laser diode or increasing the numerical aperture of an objective lens.

What is claimed is:

1. A high-density readable only optical disk, comprising:

a substrate with pits; and

one or more mask layers with a super resolution near field structure, which are made of a mixture of a dielectric material and metal particles.

2. The optical disk according to claim 1, wherein the dielectric material is metal oxide, nitride, sulfide, fluoride, or a mixture thereof.

3. The optical disk according to claim 1, wherein the dielectric material is $ZnS\text{-}SiO_2$.

4. The optical disk according to claim 1, wherein the metal particles are derived from gold, platinum, rhodium, palladium, or a mixture thereof.

5. The optical disk according to claim 1, wherein the metal particles are platinum particles.

6. The optical disk according to claim 1, further comprising one or more reflective layers.

7. The optical disk according to claim 1, further comprising a dielectric layer on at least one of the upper and the lower surfaces of the mask layer.

FIG. 1

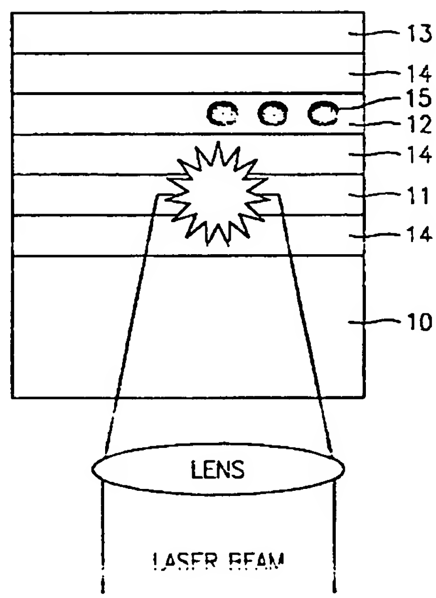
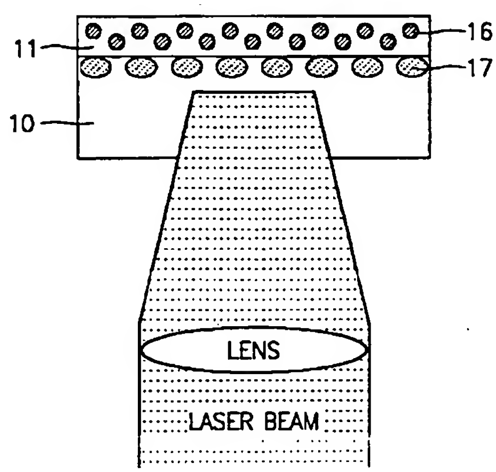
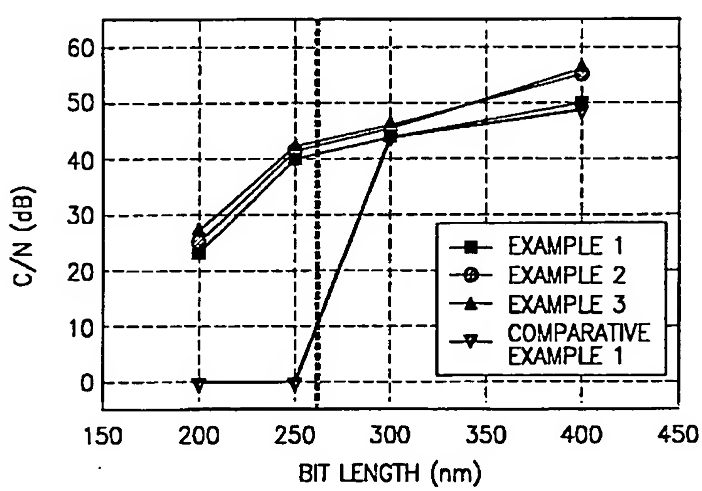


FIG. 2



11
16
17
10
LENS
LASER BEAM

FIG. 3



C/N (dB)
60
50
40
30
20
10
0
150
200
250
300
350
400
450
BIT LENGTH (nm)
EXAMPLE 1
EXAMPLE 2
EXAMPLE 3
COMPARATIVE EXAMPLE 1